Habitat complexity and biodiversity as indicators of endangered black abalone (*Haliotis cracherodii*) presence in central California

California State University Monterey Bay

Clover Lee and Corey Garza

California State University Monterey Bay, Seaside, CA

Introduction

The aim of this study is to empirically quantify species-habitat associations of endangered black abalone (**Figure 1A, B**) (*Haliotis cracherodii*) populations within Monterey Bay for efficient and effective management decisions, reserve implementation, and design. Within intertidal habitats black abalone are important keystone herbivores as their grazing activities maintain favorable habitat for other marine invertebrates. VanBlaricom et al. (1993) found black abalone to be critical components of the larger marine community as other organisms such as sea otters, octopi, lobsters, sea stars, and shorebirds feed on them. The combination of (1) over-harvesting from black abalone fisheries in the mid 1900's; (2) the bacterial disease 'Withering Food Syndrome (WS)'; (3) environmental stressors; and (4) their fickle reproductive requirements are contributing factors to massive population declines. Terrestrial landscape modeling techniques were adapted in order to analyze two predictor variables of black abalone presence within intertidal landscapes in central California. These predictor variables can provide quantitative estimates of benthic biodiversity and intertidal landscape complexity in a GIS habitat model to predict the probability of occurrence of black abalone in near shore marine habitats.

Research Question: Can intertidal landscape complexity and biodiversity be used to predict the presence of black abalone populations within Monterey Bay, CA?

Figure 1A. Healthy black abalone.

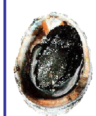

Figure 1B. Black abalone affected by WS and with reduced body mass.

Materials and Methods

Data Collection: Three sites (**Figure 2**) around Monterey Bay containing black abalone were chosen. At each site, photo surveys of two transects containing black abalone were conducted with a Topcon total station laser Surveyor (**Figure 3**) to record N, E, and Z coordinates as control points associated with each photo transect. All measurements were taken relative to Mean Lower Low Water (MLLW). High resolution digital photographs were taken with an armature (**Figure 4**) in nadir perspective for analysis of biodiversity in GIS. Black abalone movement was monitored for 5 months (July-November).

GIS Analysis: Images of photo transects were georeferenced to the corresponding control points collected from the total station in ArcMap software to create a photomosaic for all transects in each site (**Figure 5**). Habitat complexity was then calculated using the raster interpolation tool in ArcMap by calculating the standard deviation of the slope of the surveyed control points from the total station (**Figure 7**). Biodiversity was calculated by overlaying a grid over each photo and manually assigned a species code and then calculating the Shannon-Weiner Index for biodiversity (**Figure 6**).

Figure 2. Map of 3 study sites in central California.

Figure 3. Total station for collecting spatial references.

Figure 4. Photos taken in nadir perspective.

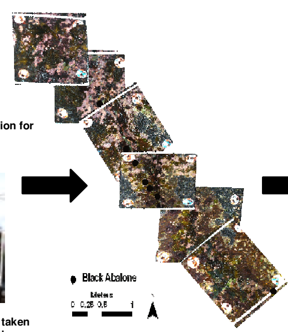

Figure 5. Photomosaic of SLPS transect 1.

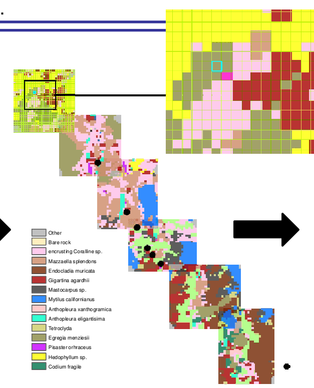

Figure 6. Biodiversity manually classified.

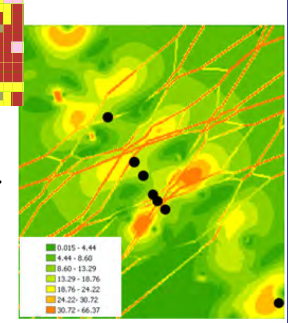

Figure 7. Complexity calculated by standard deviation of slope of surveyed points.

Preliminary Results

Generalized linear models (GLMs) were used to quantitatively estimate the relationship between black abalone presence in September 2011 and landscape derived habitat complexity and biodiversity variables. **Figure 8A**, **B** and **C** show regression analysis for strength of various combinations of predictor variables on black abalone abundance in the month of September 2011. There is no significance across model comparisons. In order to account for spatial autocorrelation, predictor variables were regressed against each other (**Figure 9** and **Figure 10**).

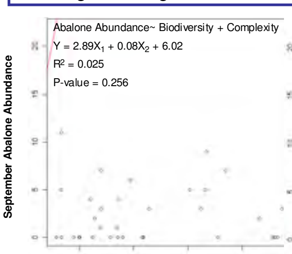

Figure 8A Biodiversity + Complexity

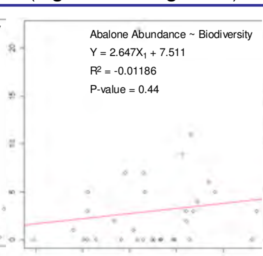

Figure 8B Biodiversity

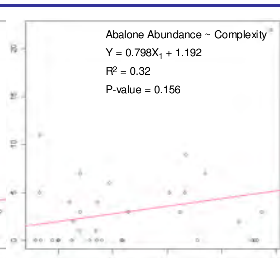

Figure 8C Complexity

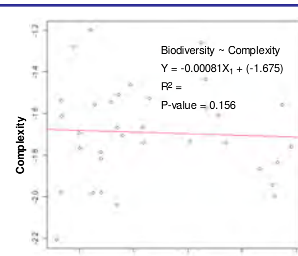

Figure 9 Biodiversity

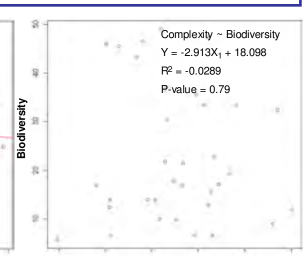

Figure 10 Complexity

Discussion

These results indicate that biodiversity and complexity alone do not explain black abalone abundance within my study areas and that there are other biological and physiological events that need to be quantified and implemented in future GLMs for more accurate predictions of black abalone abundance. Additionally, predictor variables do not influence each other, suggesting that spatial autocorrelation is not occurring. It is important that this current model be improved with polynomials and further predictor variables to be used as an accurate predictive model for black abalone habitat preservation and restoration at a broader spatial scale. Moreover, these novel methodologies for intertidal landscape surveying will be critical for advancement of empirical information that will explain species-habitat associations for a variety of marine ecosystems and the critically threatened and endangered species associated.

Acknowledgements: This project was not possible without the mentorship of Dr. Corey Garza, and the Marine Landscape Ecology Lab at CSU Monterey Bay. Thank you to CSU Council on Ocean Affairs, Science & Technology (COAST), and CSUMB's Undergraduate Research Opportunities Center (UROC) for their financial support.

Literature Cited: VanBlaricom GR, Ruediger JL, Friedman CS, Woodard DD, Hedrick RP. 1993. Discovery of withering syndrome among black abalone *Haliotis cracherodii* Leach, 1814, populations at San Nicholas Island, California. Journal of Shellfish Research 12:185-188.